4.6 Tech Roadmap Taxonomy from CCD (Long Version)

KEY:
Tier 1: Capability (one of the five 4.6 CC)

Tier 2: Current Capability Area

Tier 3: Specific Technical Sub-areas

Tier 4: Future Technical Sub-areas (areas that will feed into developing new baseline) Near (0-5 yr), Mid (5.1-10 yr), Far (10.1 + yr)

Disclaimer: The information about to be presented affords industry partners insight into on-going and pending acquisitions.

Significant portions of the information are planning in nature and are subject to change throughout the acquisition planning and acquisition strategy approval process, and in response to NAVAIRSYSCOM, DASN(A&LM) and DPAP peer reviews.

Tier 1: CC1: Human Systems Engineering, Integration, and Acquisition

Tier 2: Research, design, and development of integrated Human Systems products

Tier 3:

- Develop tools and methodologies for deriving and managing SoS requirements
    1. Tools and Methodologies to derive and manage SoS requirements

- Human performance metrics and training solutions that support Integrated Warfare Capabilities (IWC)
    1. Human performance metrics and training solutions that support IWC

- SoS/Big Data Human performance analysis tools
    1. A hybrid classification approach using down-sampling techniques and tuned hyper parameters on imbalanced datasets (TSD)

Tier 1: CC2: Optimized Human Performance and Decision Support

Tier 2: Human-Machine Interfaces

Tier 3: Develop, test, and verify enhanced interfaces that

- enhance collaborative and autonomous unmanned surveillance and strike capabilities
    1. Adaptive Training for Maintaining Attention during UAS Operations (TSD - SBIR)
    2. Identification and Definition of Unmanned Aerial System Air Vehicle Operator Performance Metrics (TSD-BAR)
    3. US - Training Experimentation & Simulation (US-TES) Lab (TSD-CIP)
    4. Stay Woke and Stay Vigilant: An Examination of Unmanned Operator Performance (TSD-WFD:SG)

5. User Interface Strategies for Human-Machine Team Training in a Simulated Swarm Task (TSD)
6. Management of multiple UAV's and payload systems by a single operator(PAX)
7. Factors involved in operator trust of automation
8. Novel methods to represent machine state to the operators
9. Techniques and approaches to represent, vary, and adapt the autonomy of controlled/monitored unmanned systems

- enhance battle management decision-making
    1. Analysis / analytic tools to log, store and convert very large data sets into useful information to expedite decision-making and reduce transmission bandwidth

- improve mission planning and real-time re-planning

- provide actionable tactical situational awareness
    1. Aircrew Control of Remote Asset Using an Electronic Kneeboard (UAV ctl with EKB) (PAX-BAR)
    2. Enabling technologies for organizing, fusing, and mining data sets to label, organize, and compare diverse more dynamic and automated abilities for rank data types

- improve manned platform information management and payload, systems, and vehicle control
    1. Eye-controlled cursor for display interaction (PAX-BAR)
    2. Techniques to minimize computational run times that can integrate HPMs within larger M&S systems and enhance the computational speed and interoperability of HPM tools

- identify all contacts and combat classifications; and track and localize potential targets at standoff ranges

Tier 2: <u>Human Performance Measurement and Assessment</u>

Tier 3:

- Improve training outcomes through application of neurophysiological data
    1. Construct Correspondence of Physiological and Subjective Measures of Hypoxia (TSD-ILIR)
    2. Cognitive models and objective measures of cognitive decision-making, visual, and auditory workload, and the associated cockpit and collaboration tools
    3. Improved modeling of cognitive neuroscience and social or cultural activity
    4. Neurocognitive and competency-based assessment data consolidation and interpretation tools

- Improve warfighter performance through application of psychometric theory
    1. Improving Cognitive Flexibility via Working Memory Training (TSD)

- Enhanced techniques for individual and team performance assessments

1. Tool for individual assessment support capabilities to support authoring, storing, selecting, implementing, and exporting performance measures, metrics, methodologies, and measurement results
2. Electronic Warfare (EW) Tactical Decision Aid (TACAID) (TSD-FNC)
3. Personal Assistant for Life Long Learning (TSD-ONR ADV. TECH.)

Tier 2: Training Methodologies for Distributed Team Competencies.

Tier 3:

- Develop LVC performance assessment technologies and after-action review strategies

- Develop performance assessment technologies for team integration in distributed cross-platform, cross-warfare teams
    1. Naval Integrated Fire Control- Counter Air (NIFC-CA X) Mission Visualization Tool (TSD-FNC)
    2. Squad Overmatch – Tactical Combat Casualty Care (TSD-ATD-Joint)
    3. Performance Measurement (PM) Engine (TSD-AWTD)
    4. Tools to define new measures and assessments rapidly and then configure them for specific training missions
    5. Advanced methods to assess instructor and/or trainee workload, performance and training effectiveness
    6. Develop Synthetic Crew/Team role player

- Develop data analyses to facilitate trainee feedback and identify novel performance trends
    1. Basic Electronics and Electricity Learning Environment (BEETLE) II Transition (TSD-219TT)
    2. Empirical Support for the Benefits of Performance Measurement Tools (TSD-219TT)

- Develop scenario authoring tool sets that use training network assets and team integration training
    1. Tools for rapid scenario generation with appropriate key triggering events to ascertain skill levels

Tier 2: Advanced Instructional Techniques

Tier 3: Real time assessment of instructor and trainee workload and performance

- Integrate instructional interventions into virtual environments to train decision-making capabilities
    1. Investigating Low-Cost Untethered Virtual Reality Technologies and the Role of Affordances on Training Effectiveness in an Immersive Environment (TSD-219BAR)
    2. Accelerating the Development of Small Unit Decision Making (ADSUDM) (TSD-FNC)

3. Tools to determine the optimal methods of data presentation to learners to maximize the effectiveness of learning and encoding content consistent with cognitive processing requirements
4. Virtual Reality for Training: Do Task Type and Method of Interaction Matter? (TSD)
5. Cockpit Geometry for Virtual Environments (PAX)
6. Distributed Virtual Reality Testbed

- Develop methods to diagnose and deliver instructional interventions to remediate knowledge and skill deficiencies
  1. Post Mission Assessment for Tactical Training & Trend Analysis (PMATT-TA) (TSD-AWTD)
  2. START applied to Medicine: Medic/Corpsman Proficiency Model (MED-PM) (TSD-DoD S&T)
  3. Augmented Training for Experiential Learning for Signal Officers (TSD-219TT)
  4. Tutoring Effectively: An Assessment of Common Heuristics (TEACH) (TSD-ONR D&I)
  5. Advanced Adaptive Training methodologies
  6. Increase the efficiency and effectiveness of the aircraft maintainer through Human Systems Integration (HSI) research (PAX)
  7. Identifying Training Technology for Enabling Deployable, High Impact Capabilities (TSD)

- Employ game-based training to improve performance
  1. Examining the Effects of Game Features on Learning Scenario Based Training (TSD-BAR)
  2. Research Exploring Multi Operator Training Environments (REMOTE) (TSD-WFD:SG)

- Develop mobile training technologies

Tier 2: Applied Human Behavior Modeling

Tier 3:

- Develop computational models of human performance
  1. Maintainer – Proficiency Model (MAIN-PM) (TSD-BAR)
  2. Machine learning algorithms that mimic human behavior and performance to recognize, synthesize, and predict patterns in data or sensory stimuli

- Develop standards for verification, validation, and accreditation (VV&A) of human performance models

- Develop Semi-automated Forces (SAF) models with human-like performance

Tier 1: CC3 Advanced Training Systems Technology

Tier 2: High-Fidelity Training Environments

Tier 3:

- Create software development environments to design and maintain high-fidelity trainers
    1. Database management systems and methods to support rapid or automated database configuration
    2. M&S to train and provide engineering test beds in support of research efficacy of various approaches to simulation for training
    3. Sound measures of trainee outcomes and rigorous experimental methodologies

- Develop real-time flight aerodynamic and visual simulation technologies
    1. 3D Interactive Aircraft Carrier Operations Planning Tool Prototype (TSD-BAR)
    2. Virtual Environment Motion Fidelity Model (TSD-BAR)
    3. Effective Measures of Training Display System Performance (TSD-SBIR: N142-104
    4. Extended Field of View (FOV) Video Aviation Training Aids (PAX)
    5. Visual systems that support high-resolution and multispectral data
    6. Multimedia and multisensory interactive displays and environments

- Develop speech recognition, synthesis functionality, and computational methods to recognize the difference between relevant and irrelevant speech
    1. Natural language interfaces for training

- Develop multi-modal sensory simulation systems and integrate into Tactical Software training applications

- Develop multi-touch interaction and 3D models

Tier 2: Simulation Interoperability and Distributed LVC Technology

Tier 3:

- Develop interoperable LVC and Cyber Warfare training simulation and technologies
    1. Crew Role Player Enabled by Automated Technology Enhancements (CREATE) (TSD-SBIR:N142-090)
    2. Environment Designed to Undertake Counter A2AD Tactics Training & Experimentation (EDUCAT2E) (TSD-FNC)
    3. Network Effects Emulation System (NE2S) (TSD-???)
    4. Integrated Warfighting Capabilities (IWC) Fidelity Investigation (TSD-BAR)
    5. Live, Virtual& Constructive (LVC) Training Fidelity (TSD-FNC)
    6. TEMPEST Modeling and Blackbody Testing for Headsets used in Voice Communication Systems (TSD)
    7. Real-Time RF Propagation Modeling in Urban Environments for Virtual and Constructive Training(TSD-BAR)
    8. Designing/architecting large scale tng events
    9. Verification and Validation of Higher Fidelity Constructive Entities for UAS Training (TSD-BAR)
    10. Distributed Virtual Reality Testbed

11. Offensive cyber training capabilities
12. Cyber Security vulnerability (penetration) assessment tools
13. Training system Cyber monitoring tools
14. Low-cost and scalable training solutions
15. Broad RF spectrum analysis test and development capability
16. Defensive cyber training capabilities

- Develop Multi-Level Security Methods to safeguard classified information in the LVC environments
    1. Cross domain solutions
    2. Enterprise Network Guard (ENG)

- Develop Mission Rehearsal Enabled Database Methods for collecting and packaging authoritative data feeds
    1. Distributed Synthetic Environment Correlation Architecture and Metrics (TSD-SBBIR:N141-006)

- Develop tools for Enhanced Constructive Environments to support instructor inserted dynamic changes to simulated environmental conditions
    1. Cross Domain Maritime Surveillance and Targeting (CDMAST) (TSD-DARPA)
    2. Dynamic Adaptive and Modular Entities for UAS (DYADEM) (TSD-FNC)
    3. Distributive training research, development and test capability for realistic SAFs

- Develop Information Load Management methods, technologies, and tools
    1. Modular Advanced Technologies Marksmanship Proficiency (MAT-MP) (TSD-T2)
    2. State-of-the-art rapid prototyping technology for training design and development

- Develop Navy Continuous Training Environment (NCTE) voice communication technologies to support FST exercises for distributed environments

Tier 1: CC4 Human Systems Analysis, Design, and Evaluation

Tier 2: Courseware Design

Tier 3: Develop technologies and methodologies for computer-based and instructor-led training for virtual environments and instructional gaming strategies

1. Utility and effectiveness of using Fleet produced maintenance videos as job performance aids

Tier 2: Training Optimization Analysis

Tier 3: Optimize training event sequencing and media utilization

1. Medical Training Validation 2 (MTV2) (TSD--DOD S&T)
2. Training System Requirements Analysis (TSRA) traceability automation tools

3. Improved methods for TSRAs to support IWC analyses
4. Improved methods for TSRAs to support maintenance training analyses

Tier 2: Training Effectiveness Evaluation (TEE)

Tier 3: Determine level of training effectiveness and outcome improvement strategies

Tier 1: CC5 Warfighter Protection, Performance, and Survivability

Tier 2: Determine Injury Mechanisms

Tier 3:

- Develop human and vehicle kinematic modeling
  1. Human injury & fatigue modeling
  2. Seat performance modeling
  3. Aircrew Accommodation Lab Digital Human Modeling (DHM) Capabilities

- Develop test fixtures for dynamic physical re-creation of vehicle crash, aircraft ejection, and windblast

- Develop musculoskeletal injury modeling and risk prediction
  1. Whole body injury prediction modeling
  2. Low-back pain modeling
  3. Portable Human Vibration Measurements
  4. Neck injury metrics & modeling

- Develop thermoregulatory modeling to predict response to cold water immersion and extreme temperatures exposures

- Develop models to correlate excessive noise/laser exposure with hearing/eye damage
  1. Improved flight deck personnel & maintainer (Triple) Hearing Protection
  2. Earplug integrated pressure sensors
  3. Earplug venting
  4. Ultrasonic wireless communications development
  5. Non-invasive Custom Ear Canal mapping and On-site Custom Earplug manufacturing
  6. On-site Custom Earplug manufacturing
  7. Improved Ear seal material
  8. Active Noise Reduction assessment methodology
  9. Improved Earcup material
  10. Active Noise Reduction device evaluation
  11. Wireless Earplugs
  12. In-ear/on-person noise exposure dosimetry
  13. Improved FW Hearing Protection Non-invasive Ear Canal mapping
  14. Improved Jet (ANR) Hearing Protection
  15. Improved Flight Dech and Aircrew Hearing Protection

16. On-site Custom Earplug Provision Improved FW Prop & Rotary Wing (ANR) Hrg Prot
17. Airworthy Noise Measurement Fixture
18. Automation/Upgrade of the Auditory Performance Laboratory Modified Rhyme Test Capability

- Develop life support systems (LSS) to improve parachute performance
    1. Improved parachute materials
    2. Improved parachute materials & head restraint designs
    3. Parachute probabilistic modeling
    4. Improved Fixed Wing non-ejection parachute/restraint system
    5. NACES Envelope Expansion (improved drogue chute, thrust direction, parachute)
    6. NACES envelope expansion (improved head and neck restraints); Improved FW non-eject chute & restraint

Tier 2: Develop Injury Prevention and Mitigation technologies

Tier 3:

- Develop mitigation technologies to offset the effects of acceleration loading during normal and emergency operations
    1. Air bladder pressurized G Suits Improved durability materials
    2. Improved maintainability G Suit
    3. Fatigue indicating webbings
    4. Improved Aircrew & passenger crash protection & egress
    5. Improved NACES ejection seat Sustainability: Sequencer redesign & Service Life Assessment Program
    6. Ejection Seat component surveillance
    7. Aircrew restraint pre-tensioner
    8. Crash dynamics recording
    9. Gunner Seat ergonometric improvements
    10. Lumbar support improvements
    11. Custom cushions & lumbar support
    12. Active high-endurance seat cushion
    13. Active vibration dampening
    14. Lap belt pre-tensioner
    15. Improved crash dynamics recording
    16. Lower profile emergency egress bottles
    17. Higher endurance seat cushion
    18. Personal Lumbar Support
    19. Improved endurance MH-60 Gunner Seat
    20. Reduced weight & bulk man-mounted survival equipment

- Develop life support systems (LSS) to protect against environmental stresses
    1. Improved fire protection & durability flight suit material
    2. Improved Multi-Climate Protection materials
    3. Improved Multi-Climate Protection materials

4. Improved Undergarment thermal regulation
5. Mask-on Hypoxia Training Device
6. E-2D airframe vibration study
7. Cold-weather footwear & extreme foul weather gear
8. Thermoregulatory product exploration
9. Cold Weather Boots
10. Regulated body cooling
11. Regulated body heating
12. Human vibration measurement
13. Seat vibration induced injury reduction

- Develop LSS to protect against ballistic, directed energy, CBRN and vision threats
  1. Contamination Indicator Decontamination Assurance System (CIDAS)
  2. Biological agent aircraft decontamination system
  3. Chemical agent detection system
  4. Lighter weight, lower bulk, improved protection coveralls
  5. Uniform Integrated Protection Ensemble (UIPE) products
  6. Ballistic injury modeling
  7. Shipboard Chem Bio Aircraft Decontamination
  8. Stand Off chemical agent detection
  9. Lightweight, reduced bulk, flexible ballistic protection

- Develop technologies to monitor human physiologic response and LSS functionality
  1. Aircrew Physiologic Monitoring and Warning System
  2. Cognitive Recovery Time after Hypoxia Exposure
  3. Effects of Low Frequencies on Aircrew
  4. Determination of the Effect of Exercise on Physiologic and Cognitive Response to Exposure to Hypoxic Hypoxia

- Develop enhanced research protocols to determine LSS effectiveness to support cognitive and physiologic response against military relevant threats
  1. Physiologic and cognitive effect of a multi-stress environment on performance in a flight simulator
  2. Placebo Effect of Hypoxia Using the ROB-D
  3. Construct Correspondence of Physiological and Subjective Measures of Hypoxia

Tier 2: Ensure Warfighter and Support Personnel Accommodation

Tier 3:

- Create and validate 3-D computer models of humans, equipment, controls, cockpits and workstations

- Design, develop, and validate Digital Human Models to determine physical limitations and optimize warfighter and maintainer cockpits, workstations, and work-area design
  1. Digital Human Modeling

- Improve ability to quantify speech intelligibility performance and effectiveness of hearing protection devices and communications systems
    1. Ultrasonic wireless communications producibility

Tier 2: Develop/Evaluate Electro-Optical (EO) Sensors, Displays, Interfaces and Devices

Tier 3:

- Develop analog and digital head mounted systems; audio, tactile, and visual displays
    1. Improved maintainer & flight deck personnel head protection
    2. Common RW Helmet
    3. Helmet/Head & Neck injury modeling
    4. Common RW Helmet enhancements
    5. Common FW Helmet
    6. Improved Fixed Wing helmet fit, HMD stability & maintainability
    7. Low cost digital interface eyepiece for Rotary Wing
    8. See-through display technology development
    9. Automatic Tinting for display visor development
    10. Next generation day/night tactical helmet: high resolution, all-weather, multi-spectral display with tactical data overlay
    11. Human Vision Test System Technology Transfer
    12. Field of View Effectiveness Study
    13. New Capability to the Helmet Impact Testing Drop Tower For Testing Inertia Reels and Energy Absorbers

- Develop and validate automated machine vision test capabilities
    1. Eye protection integrity monitor

Tier 2: Develop Equipment and Procedures Related to Aircraft LSS Performance, and Maintainability

Tier 3:

- Develop and upgrade legacy LSS for Survival, Evasion & Recovery
    1. Soft armor assessment (Army)
    2. Enhanced soft material armor
    3. Data/power transporting e-textiles & integrated bio-sensors
    4. Reduced bulk LPU/Life Raft material
    5. Non-Combat Survival Radio requirements definition
    6. Improved flotation
    7. Sustainable Non-Combat Survival Radio
    8. Smaller profile, auto-activation, software reprogrammable Combat Survival Radio
    9. Improved cold water survival suit

- Develop and upgrade legacy LSS for oxygen generation, system fault detection and isolation, hypoxia investigation, and prognostic health monitoring
    1. Improved common respiration protection for Rotary Wing and Strategic Aircraft

2. Volatile organic compounds contaminant assessment
3. Improved common respiration protection for Tactical Aircraft
4. Next Gen Aircrew Protective Ensemble
5. Oxygen system monitoring, fault detection & diagnostics
6. Physiological monitoring, prediction & warning; Physiological limits assessment
7. Oxygen Monitor Integrity Check
8. Personal physiological condition monitoring; Increased capacity Emergency O2
9. Improved Oxygen Concentration
10. Personal Helicopter Oxygen Delivery System (PHODS)
11. Aircraft-mounted Toxin sensor, scrubber & warning system

- Develop and improve maintenance concepts for optimizing LSS performance
- Develop and implement analytical methods and procedures for conducting engineering investigations

Tier 2: Aircraft Interior and External Lighting Compatibility

Tier 3: Develop lighting and night vision compatibility requirements specification and verification

Enhanced Visual Acuity (EVA) Inc. 1:

1. Enhanced low-light illumination, reduced scintillation, reduced halo effect, lighter weight with symbology overlay
2. EVA Inc. 2: Enhanced digital Situational Awareness
3. Improved Visual Acuity II Tube NVGs
4. Reconfigurable high resolution AMOLED micro-display
5. Reconfigurable high resolution AMOLED micro-display – Follow on
6. Digital Night Vision System Test Capability Development
7. Next Gen EBAPS (ISIE-19) NIR digital sensor
8. Solid state multi-spectral extreme low light level fused sensor display
9. Automatic Tinting for display visor development